CMMI Pathfinding in 45 Minutes

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Notes:

1. If you are not familiar with the CMM, please find general information about this model from the SEI publications at [9]. Another source model of the CMMI is the SW-CMM version 2.0 draft C that was never officially released.
2. If you are not familiar with the EIA/IS 731, please find information about this model from the publications at [5].
3. If you are not familiar with the CMMI please find general information about this model in our article [6].
4. This document is based on version 1.1 of the CMMI-SE/SW/IPPD/SS.
5. ISO TR 15504 is currently not an ISO standard, but a technical report (TR).
6. Capability Maturity Model and CMM are registered in the U.S. Patent and Trademark Office.
7. CMMI, CMM Integration, PSP, SCAMPI, and TSP are service marks of Carnegie Mellon University.

1 Introduction

The succession of the Capability Maturity Model for Software (SW-CMM) and the System Engineering Capability Maturity Model (EIA/IS 731) by the Capability Maturity Model-Integrated (CMMI) will expose many organizations that currently use either the SW-CMM or the SE-CMM to the challenge of an effective and efficient transition from the old models to the new one. This paper advices on how this transition can be accomplished based on

- the description of changes in the model architectures,
- the analysis of changes in PAs through mapping tables,
- the description of new PAs together with sample processes and practices,
- the presentation of feedback from early adaptors at the SEI Technology Transition Workshop,
- the discussion of criteria for the choice of the model representation, and
- the proposal of possible transition paths.

We will give advice on transitioning to the CMMI for the following organizational situations:

1. Organization appraised to a certain SW-CMM maturity level.
2. Organization appraised to a certain EIA/IS 731 capability level profile.
3. Organization not appraised so far, but intending to get formally appraised in the future.
4. Organization not appraised so far with no intention to get formally appraised in the future.

We included the last case for the reason that the CMMI standard can be beneficial for organizations that do not intend to get formally appraised.
It should be noted that we are putting more weight on the SW-CMM to CMMI perspective. For more information on the EIA/IS 731 to CMMI transitioning, please refer to [3].

2 Changes in the Architectures

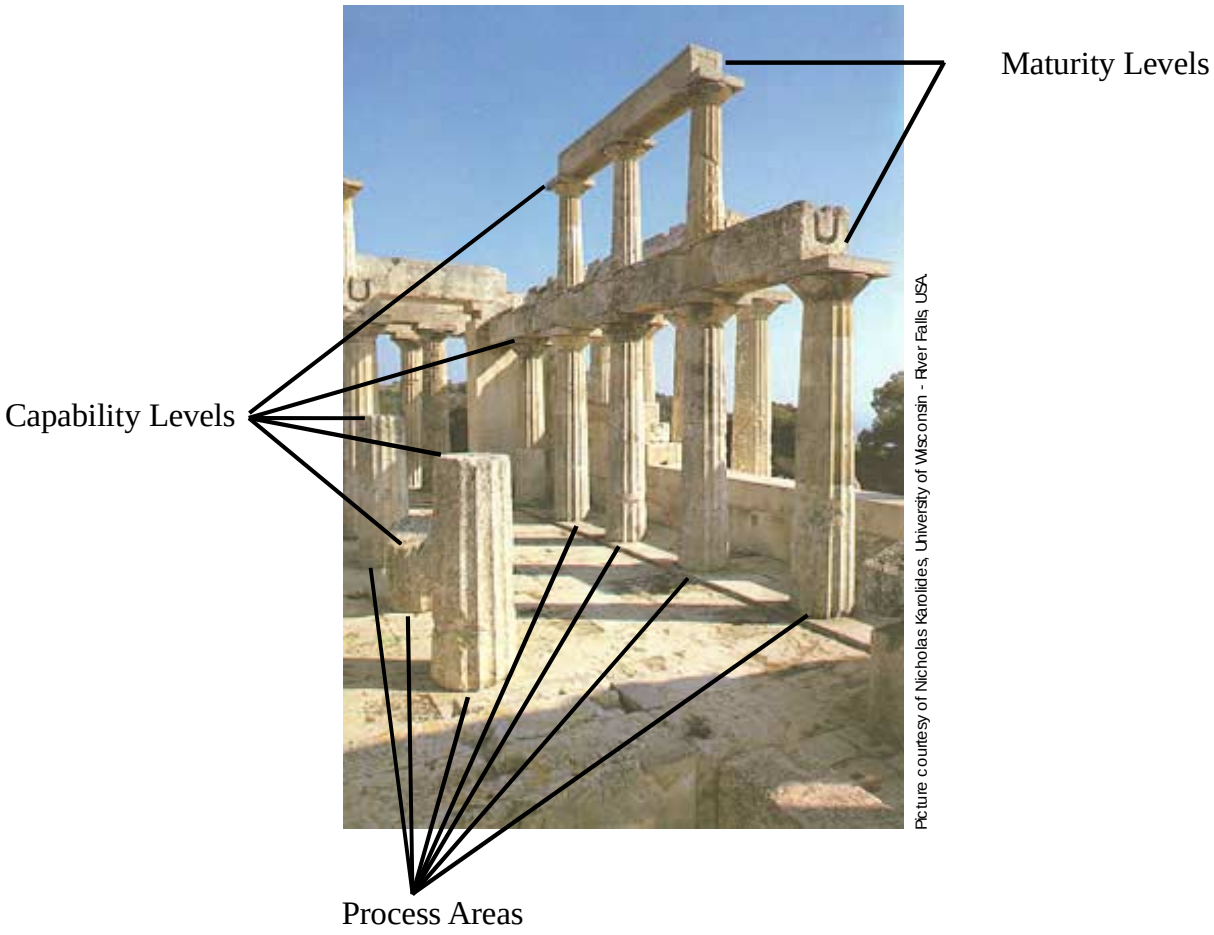
2.1 General Considerations

The CMMI is a fusion of the two source models SW-CMM and EIA/IS 731. The basic aspects of the source model's architectures is preserved in the two representations of the CMMI:

- Staged: The representation related to the SW-CMM based on 5 maturity levels.
- Continuous: The representation related to the EIA/IS 731 based on 6 capability levels.

A maturity level is reached if a defined set of process areas is sufficiently covered (e.g. the generic and specific goals are covered) by the processes and practices of an organization.
A capability level is a rating of an individual process area. Consequently there is only one maturity level an organization can have, but a distinct capability level for each process area measured. This is further illustrated in Figure 1.

Figure 1: The Relationship of capability and maturity levels in the CMMI.



2.2 Model Elements of the SW-CMM, the EIA/IS 731, and the CMMI

Both of the source models have their own elements and concepts. The CMMI leads to the advantage of a common vocabulary.

Table 1: Comparison of Model Elements and Concepts.

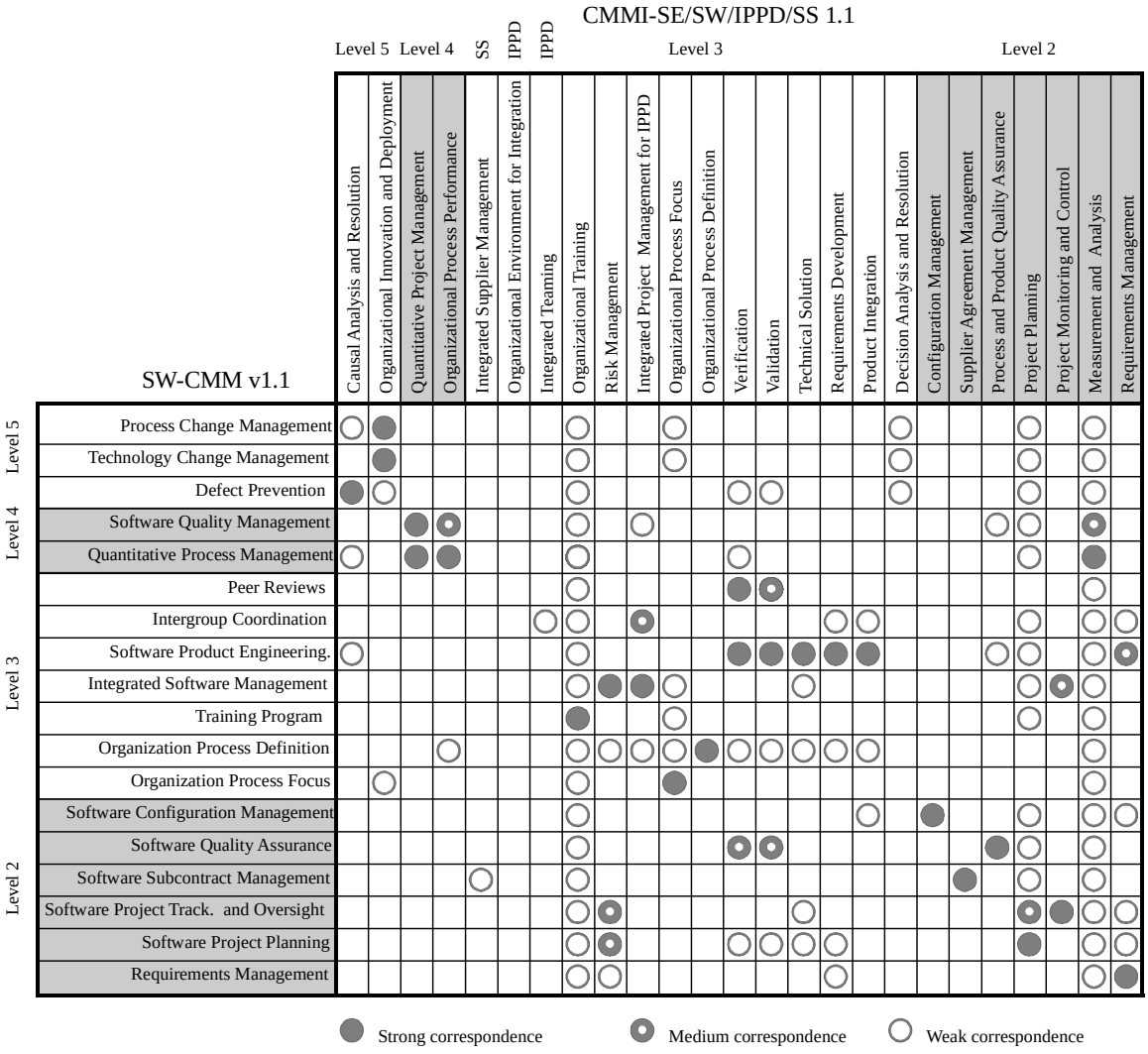
CMM Model Element Name	EIA/IS 731 Model Element Name	CMMI Model Element Name
-	-	Representation (2)
Process Category (3)	Category (3)	Process Area Category (4)
Key Process Area (18)	Focus Area (19)	Process Area (22-25) ^
Common Feature (5)	Generic Practice (12) Generic Attribute	Common Feature (4) * Generic Goal (5) Generic Practice (18)
Process Goal (53)	Themes (77)	Specific Goal (48)
Key Practice (316)	Specific Practice (381)	Specific Practice (168)
Examples	Notes	Typical Work Products
		Discipline Amplification
		Elaborations
		Sub Practices

* Staged Representation only. ^ Actual number depends on the chosen model.

3 Changes in the Process Areas

3.1 SW-CMM v1.1 KPAs and Corresponding CMMI-SE/SW/IPPD/SS v1.1 PAs

This table is a bidirectional mapping between the two models (CMMI PAs sorted by maturity levels):



The following observations can be made:

1. "Software" is dropped from PA names. The model is applicable to a range of disciplines.

2. There is not much turnover in the level 4 and 5 KPAs: The Process Change Management and the Technology Change Management KPAs are merged into the Organizational Innovation and Deployment PA. Other PAs have been renamed.

3. Major changes have happened with the level 3 KPAs:

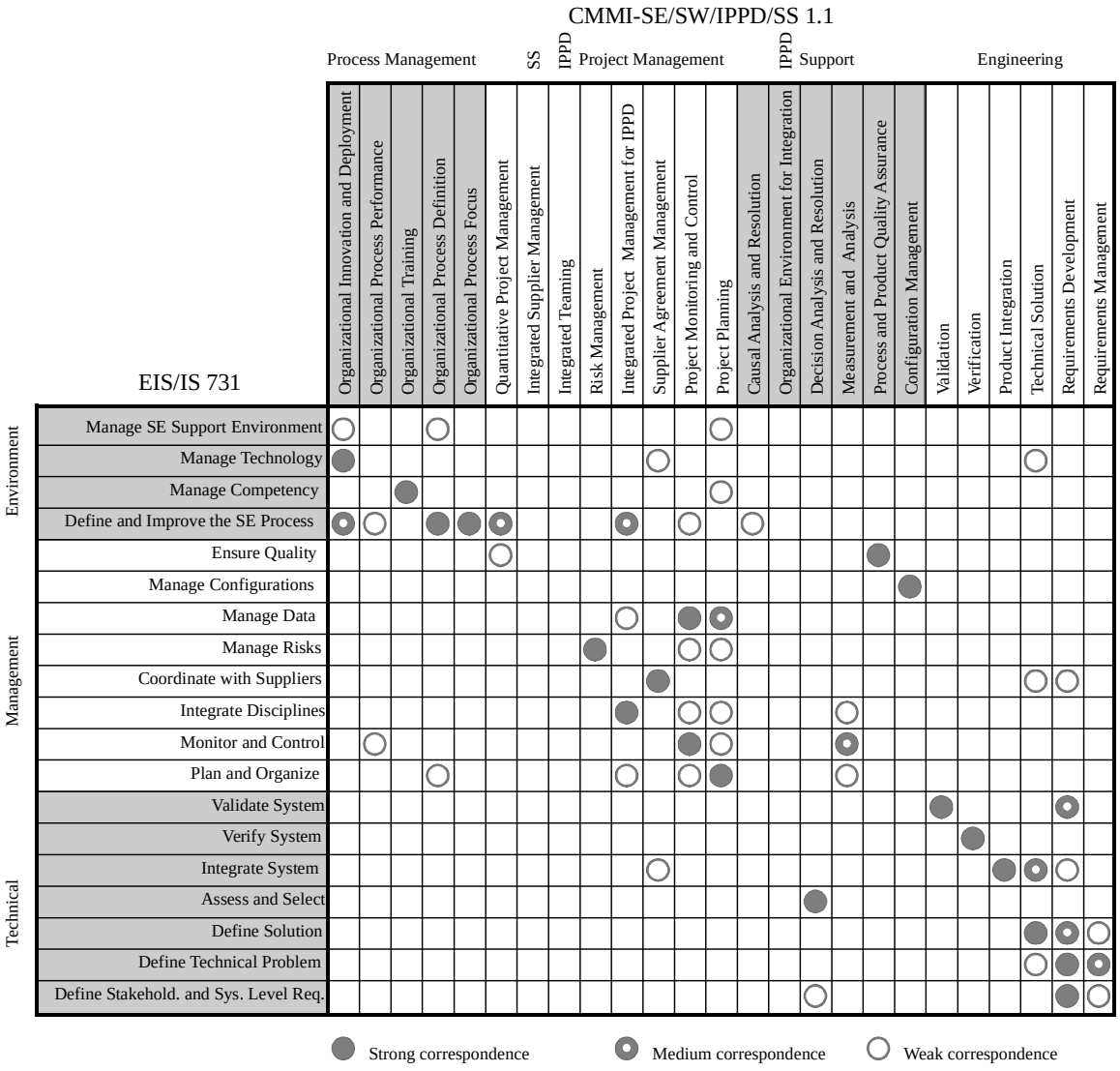
   - Software Product Engineering is split into 5 new PAs.
   - The Peer Reviews KPA is split into the Verification and Validation PAs.
   - Parts of the Intergroup Coordination and Integrated Software Management KPAs have been put into the new PAs Integrated Project Management and Risk Management.

- The Organizational Environment for Integration and the Integrated Teaming PA are introduced with the Integrated Product and Process Development (IPPD) version of the standard.
- The Integrated Supplier Management PA is introduced as the only PA specific to the Supplier Sourcing (SS) version of the standard.

4. The introduction of the Measurement and Analysis PA is the significant change at level 2.

3.2 EIA/IS 731 FAs and Corresponding CMMI-SE/SW/IPPD/SS v1.1 PAs

This table is a bidirectional mapping between the two models (CMMI PAs sorted by PA categories):



The following observations can be made:

1. Some consolidation has happened in the environment FAs:

   - The Manage System Engineering Environment and the Define and Improve the System Engineering Process FAs have been removed and partly transferred to other PAs.

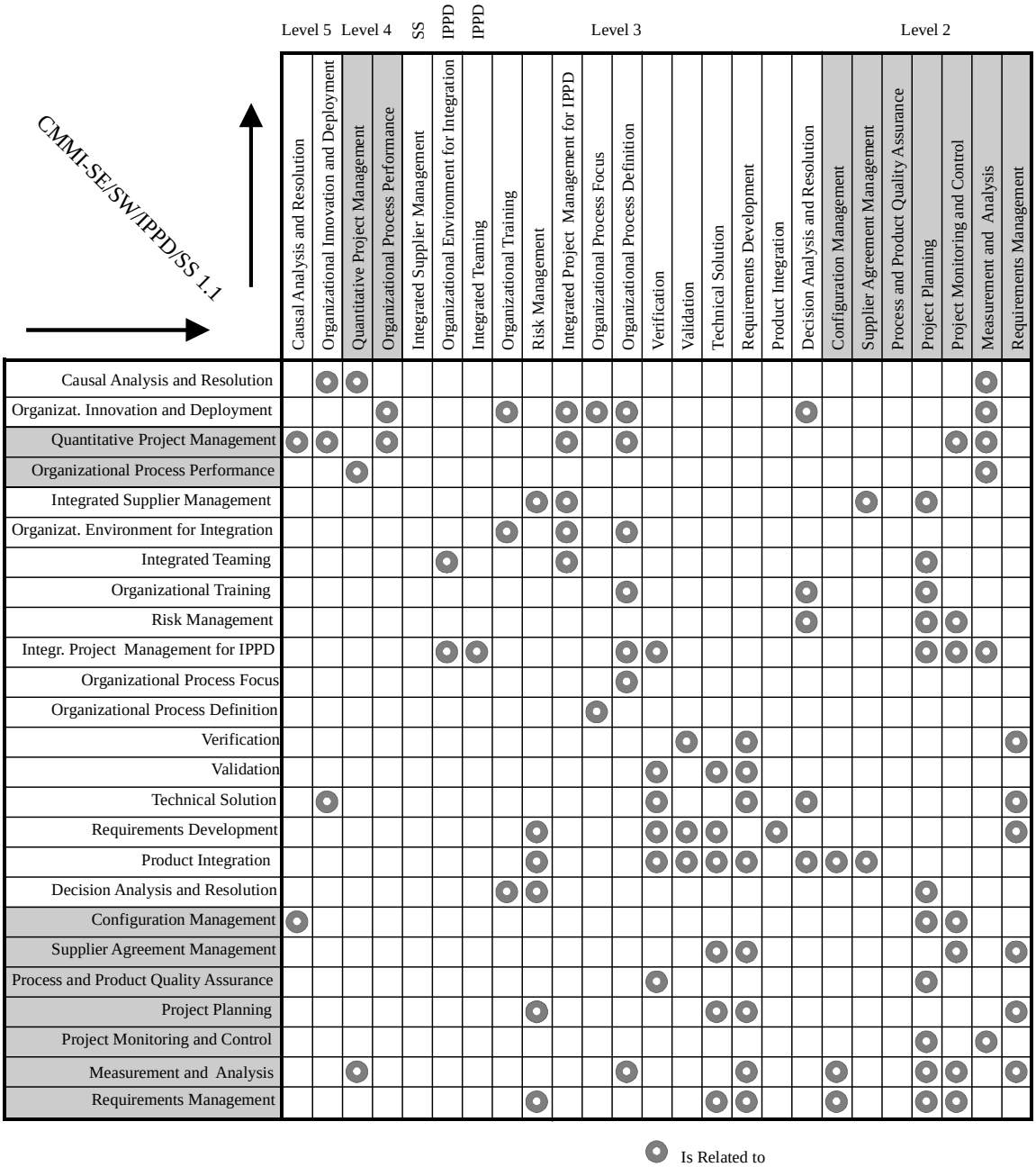
2. Changes happened in the Management FAs:

- The Manage System Engineering Environment and the Define and Improve the System Engineering Process FAs have been removed and partly transferred to other PAs.

3. In the technical focus area the major change is the merging of the FAs Define Solution, Define Technical Problem, and Define Stakeholder and System Level Requirements into the Technical Solution and Requirements Development PAs.

3.3 Internal PA Relationship Matrix

The following table is a unidirectional "is related to"-mapping between the CMMI PAs. It is based on the section "Related Process Areas" that is given for each PA of the standard.



It has been stated that the CMMI introduces some redundancies. From this table we can identify some of them:

- There is a major overlap between the PAs Project Planning and the Project Monitoring and Control.
- The PAs Technical Solution, Requirements Development, and Requirements Management are highly interrelated.
- The Verification and Validation PAs are closely related.

4 New Process Areas from a SW-CMM Perspective

Level	PA		Discipline
5	Organizational Innovation and Deployment	OID	SE/SW
4	Organizational Process Performance	OPP	SE/SW
3	Integrated Supplier Management	ISM	SS
	Organizational Environment for Integration	OEI	IPPD
	Integrated Teaming	IT	IPPD
	Risk Management	RSKM	SE/SW
	Verification	VER	SE/SW
	Validation	VAL	SE/SW
	Technical Solution	TS	SE/SW
	Requirements Development	RD	SE/SW
	Product Integration	PI	SE/SW
	Decision Analysis and Resolution	DAR	SE/SW
2	Measurement and Analysis	MA	SE/SW

4.1 Measurement and Analysis

4.1.1 Purpose

“The purpose of Measurement and Analysis is to develop and sustain a measurement capability that is used to support management information needs.”

4.1.2 Explanation

The process area goals require to establish a measurement process capable of delivering project, product, and process metrics as well as the necessary means to analyze and use measured and derived data for decision support, statistical control, and management information. In addition the goals cover the adequate means for presentation, storage, and retrieval of measured and derived data in a Data Warehouse or other repository. The requirement for suitable measurement processes is the most significant change in the level 2 PAs.

4.1.3 Sample Processes or Practices

- GQM Metrics Program.
- SPC.
- Task effort measurement.

4.2 Decision Analysis and Resolution

4.2.1 Purpose

“The purpose of Decision Analysis and Resolution is to analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria.”

4.2.2 Explanation

The process area goals require a formal evaluation and decision-making process.

4.2.3 Sample Processes or Practices

- Best Value Assessment Process.

4.3 Product Integration

4.3.1 Purpose

“The purpose of Product Integration is to assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product.”

4.3.2 Explanation

The process area goals require the effective and efficient integration of system parts that could be COTS-software, subsystems, or legacy systems.

4.3.3 Sample Processes or Practices

- Product life cycle integration test phase.

4.4 Requirements Development

4.4.1 Purpose

“The purpose of Requirements Development is to produce and analyze customer, product, and product-component requirements.”

4.4.2 Explanation

The new process area requirements development reflects that requirements are not there from the beginning, but have to be developed over time.

4.4.3 Sample Processes or Practices

- Requirements Development practices as recommended by Steve McConnell in [12].

4.5 Validation

4.5.1 Purpose

“The purpose of Validation is to demonstrate that a product or product component fulfills its intended use when placed in its intended environment.”

4.5.2 Explanation

The process area goals are intended to assure that the product or product components meet the expectations of the users in the operational environment. Validation answers the question “Did we build the right system or work product?”.

4.5.3 Sample Processes or Practices

- Acceptance Testing.
- Beta-Testing and Field Trials.
- Software Reliability Testing.
- Load and Stress Testing.

4.6 Verification

4.6.1 Purpose

“The purpose of Verification is to ensure that selected work products meet their specified requirements.”

4.6.2 Explanation

The process area goals require the establishment of inspection and testing activities for product verification purposes. Verification answers the question “Did we build the system or work product right?”.

4.6.3 Sample Processes or Practices

- Fagan Inspection Process.
- Unit Testing.

4.7 Technical Solution

4.7.1 Purpose

“The purpose of Technical Solution is to design, develop, and implement solutions to requirements. Solutions, designs, and implementations encompass products, product components, and product-related lifecycle processes either singly or in combinations as appropriate.”

4.7.2 Explanation

The process area goals require the development of solution alternatives, their evaluation and selection.

4.7.3 Sample Processes or Practices

- Use case development.
- Solution Impact Analysis.
- Piloting.
- Prototyping.

4.8 Risk Management

4.8.1 Purpose

“The purpose of Risk Management is to identify potential problems before they occur, so that risk-handling activities may be planned and invoked as needed across the life of the product or project to mitigate adverse impacts on achieving objectives.”

4.8.2 Explanation

The process area goals require the establishment of a risk management process that identifies, quantifies, and prioritizes risks. In addition it includes the necessary planning activities for risk mitigation and contingency.

4.8.3 Sample Processes or Practices

- AVOCA CMMI Compatible Risk Management Process [7].

4.9 Integrated Project Management for IPPD

4.9.1 Purpose

“The purpose of Integrated Project Management is to establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is

tailored from the organization's set of standard processes. For Integrated Product and Process Development, Integrated Project Management also covers the establishment of a shared vision for the project and a team structure for integrated teams that will carry out the objectives of the project."

4.9.2 Explanation

The goals of this PA require the use of project management practices from the organizational process assets and the transfer of proven practices to this repository. In addition the goals require the involvement of all stakeholders for the management of the project.

4.9.3 Sample Processes or Practices

- USC WinWin Spiral Model.
- Product life cycle with quality gates.

4.10 Integrated Teaming (IPPD)

4.10.1 Purpose

"The purpose of Integrated Teaming is to form and sustain an integrated team for the development of work products."

4.10.2 Explanation

The Integrated Teaming PA requires processes to establish cross-functional teams with members from different organizational units or organizations. Means for the cooperation between teams are also necessary.

4.10.3 Sample Processes or Practices

- Team Building activities.
- Preparation for cross-functional and cross-cultural teams.
- Team ownership.
- Periodical team meetings.

4.11 Organizational Environment for Integration (IPPD)

4.11.1 Purpose

"The purpose of Organizational Environment for Integration is to provide an Integrated Product and Process Development (IPPD) infrastructure and manage people for integration."

4.11.2 Explanation

See DoD IPPD Handbook [8].

4.11.3 Sample Processes or Practices

See DoD IPPD Handbook [8] and [9].

4.12 Integrated Supplier Management (SS)

4.12.1 Purpose

"The purpose of Integrated Supplier Management is to proactively identify sources of products that may be used to satisfy the project's requirements and to manage selected suppliers while maintaining a cooperative project-supplier relationship."

4.12.2 Explanation

The Integrated Supplier Management PA goals require a process that identifies, analyses, and evaluates potential suppliers, manages the relationships with existing suppliers, and puts those relationships under review.

4.12.3 Sample Processes or Practices

- Supplier Relationship Management (SRM).
- Supplier Audits.

5 Early Adaptors Recommendations

In May of 2001 the SEI Accelerating Software Technology Adoption Initiative (ASTA) conducted a workshop with participants from organizations currently transitioning to the CMMI. Please find more complete information on the Workshop in [2].

5.1 General Recommendations

1. Organizations that currently use the SW-CMM or EIA/IS 731 should set up a CMMI transition charter or plan and accompanying planning activities. Even if the organization does not intend to make a transition it should not simply ignore the CMMI.

2. During the transition to the CMMI the organization should be clear on what to do with ongoing product development or maintenance projects that might be influenced by new or changed practices or processes.

3. It has been repeatedly stated that the use of Class B/C Appraisals, which are more informal than the Class A Appraisals, are very helpful in detecting goals not sufficiently covered by the current processes.

4. “Train your processes not the model.” As with any standard the CMMI is a mean to an end. If actual capability of your processes is the concern, conformance to the standard will follow.

5. Integrate the CMMI with other assessment or quality models used by your company to eliminate multiple assessments (e.g. satisfying CMMI L2/3 could qualify as ISO 9001 certification).

5.2 Specific Recommendations

This is a condensed list from [2] of transition support practices “what works”:

- **Contact and Awareness**
  - Think CMMI; reference cards; promotional materials.
  - Set goals in company through quality councils and balanced scorecards
- **Understanding**
  - Methods for self-appraisal; gap analysis; mini-appraisals; class B&C appraisals that relate gaps to the organization’s processes.
  - Use compliance matrices to document current practices in relation to PA practices.
- **Limited Adoption**
  - Role-based training.
  - Tailoring guidance/strategies for different organizational contexts.
  - Transition steering group.
- **Institutionalization**
  - CMMI best-practice based templates/checklists/assets.
  - Integrating process review into project management reviews.

This is a condensed list from [2] of transition support practices “what is needed”:

- **Contact and Awareness**
  - Widely published list of organizations who have decided to transition, to use for source selection.
  - A clear vision of what CMMI is.
  - Integrated product suite across the adoption spectrum, a “whole product”.

  - Well-written PR materials targeting senior managers, project managers, and system engineers.
- **Understanding**
  - Technical sales pitch, describing the promise of CMMI.

This is a list from [2] about “what to avoid”:

- **Trap or Timewaster Votes**
  - Have Process Engineering Group (PEG)/Software Engineering Process Group (SEPG) meetings with no project representation.
  - Overdo (e.g., write 100 page procedure) Risk, M&A, DAR process areas when going from SWCMM to CMMI.
  - Don’t link process to product quality, cost, schedule, and performance.
  - Rely on current “Introduction to CMMI” training as sufficient for appraisal team training.
  - Let experts/zealots write the procedures.
  - Set artificial level requirements, and put the people with the lowest estimate in charge.
  - Spend most of your time on the open-ended questions during a SCAMPI appraisal.
  - Don’t train–it costs too much. Just do it–follow the appraiser.
  - Management should dictate process changes without any coordination, because it speeds things up.
  - Don’t bother to capture the hearts and minds of middle management.
  - Select your most important (i.e., crucial) project as your CMMI pilot–get biggest bang for your buck.
  - Change the organization structure 6 months before the appraisal, to clarify reporting structures.
  - Include zealots in specific areas (like measurement, international standards) in your appraisal team.
  - Tell people they can understand the model just by reading it.
  - Align your practices exactly to the CMMI, instead of to what you do.
  - Use a benchmark method (e.g. Class A appraisal) for first contact.
  - Put as many Lead Appraiser on your appraisal team as possible. Different opinions add spice.
  - Forget the “I” phase in the IDEAL model.
  - Use the Introduction to CMMI course as first contact for program managers.
  - Rotate your SEPG leader every three months–use someone with a fresh look who has never read the policy.
  - Have grass roots process improvement team led by development manager with engineer representatives from each team. Do not use process engineers to drive the process, use them to do gap analysis and internal assessments.

6 Transition Paths to the CMMI

6.1 General Considerations

You should start with the transition effort after a recent appraisal and long before a future intended Class A appraisal.

6.2 Organization appraised to a certain SW-CMM maturity level

The native representation to choose is the staged model, because the staged model is institutionalized in the thinking of the organization. However, if ISO 15504 will have relevance for your organization in the future or your organization needs a more business driven, flexible approach, in the long term the continuous model will be the better choice. With the necessary changes, particularly in the level 3 PAs, substantial investment for the SW-CMM to CMMI transition is necessary in any case.

6.3 Organization appraised to a certain EIA/IS 731 capability level profile

The native representation to choose is the continuous model. There is hardly any reason for choosing the staged representation.

6.4 Organization not appraised so far, intending to get appraised

You should do a mini-appraisal (CMMI Class C Appraisal) or a gap-analysis in order to determine where your organization currently stands. Most likely you should choose the continuous representation of the CMMI for the reason of increased flexibility and ISO 15504 conformance.

6.5 Organization not appraised so far with not intention to get appraised

The CMMI can and should be used as source of Software Engineering knowledge. If you have currently no formal processes in place and you want to change this, you should have a look at the level 2 and 3 PAs. Actually, we consider the Risk Management PA as the single most valuable starting point, because it takes only few resources to establish it and the identified risks can be drivers to establish other processes and practices.

The most rewarding PA candidates to implement after you have established the Risk Management PA are:

1. Project Planning,
2. Requirement Management,
3. Configuration Management,
4. Verification,
5. Validation,
6. Organizational Training, and
7. Measurement and Analysis.

7 Conclusions

The CMMI standard is a composite of two source models. The general strategy of the CMMI product team was to preserve as much of the respective source model as possible. With the defence industry background of the source models one could venture that it was difficult to convince people to give up on established positions. This is reflected by the two representations and the fact that the number of PAs has grown significantly. This situation certainly increased the redundancy contained in the model. It could be beneficial for a future release of the standard to allow for the reduction of rated process areas without loosing the option of getting a formal maturity rating, as it is currently the case. Even the removal of some PAs schould be considered.

8 Acknowledgements

We would like to thank Neda Gutowski for her extremely helpful review of this report.

9 References

1. D. Ahern et al., *CMMI Distilled*, Addison-Wesley, 2001; http://www.sei.cmu.edu/cmm .

2. L. Carter et. al., *The Road to CMMI: Results of the First Technology Transition Workshop CMU/SEI-2002-TR-007*, SEI, 2002; ftp://ftp.sei.cmu.edu/pub/documents/02.reports/pdf/02tr007.pdf .

3. A. Clouse, C. Wells, *Transitioning from EIA/IS 731 to CMMI*, Crosstalk, July 2000; http://www.stsc.hill.af.mil/crosstalk/2000/jul/clouse.asp .

4. CMMI Product Team, *CMMI-SE/SW/IPPD/SS V1.1*, SEI, 2002; http://www.sei.cmu.edu/cmmi .

5. EIA, INCOSE, and EPIC, *EIA/IS 731 Systems Engineering Capability Model*, EIA, 1999; http://www.geia.org/sstc/G47/731dwnld.htm .

6. G. Keefer, H. Lubecka, *The CMMI in 45 Minutes*, Technical Report, AVOCA GmbH, 2002; http://www.avoca-vsm.com/Dateien-Download/CMMI45Minutes.pdf .

7. G. Keefer, *A CMMI Compatible Risk Management Process*, PSQT South 2002 Presentation; http://www.avoca-vsm.com/Dateien-Download/CmmiRiskManagement.pdf .

8. Office of the Under Secretary of Defense, *DoD Integrated Process and Product Development Handbook*, August 1998; http://www.acq.osd.mil/io/se/ippd/ippd_hdbk.doc .

9. M. C. Paulk et al., *SEI SW-CMM V1.1*, SEI, 1993; http://www.sei.cmu.edu/cmm .

10. Danny L. Reed et al., Institute of Defense Analyses, *Ford Motor Company's Investment Efficiency Initiative: A Case Study*, April 1999; http://www.acq.osd.mil/io/se/ippd/fordcase.pdf .

11. D. Weinberger, P. Rogoway, *CMMI Overview Presentation*, Motorola Inc. 2001.

12. S. McConnell, *Software Project Survival Guide,* Microsoft Press, 1997.

10 Abbreviations and Acronyms

- CMM Capability Maturity Model
- CMMI Capability Maturity Model Integrated
- EIA Electric Industry Association
- GQM Goal Question Metric - Approach
- IPPD Integrated Product and Process Development
- IS Interim Standard
- ISO International Organization for Standardization
- KPA Key Process Area
- PA Process Area
- SE System Engineering
- SEI Software Engineering Standard
- SEPG Software Engineering Process Group
- SPC Statistical Process Control
- SS Supplier Sourcing
- SW Software Engineering

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